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ABSTRACT

Background information on the history and rationale for Tech Prep introduces the description of a study that examines the perceptions of students enrolled in Applied Mathematics 1 and Applied Mathematics 2 courses which are based on the Center for Occupational Research and Development's (CORD) applied mathematics curriculum. The primary goal is to compare the perceptions of students in applied math and students in algebra 1 on mathematics as a school subject. Students (n=490) in four Missouri school districts participated in this study which employed a posttest-only control group design. Findings suggest that applied courses enable students to have positive perceptions of mathematics as a subject and provide a basis for students to develop an appreciation for the use of mathematics on the job. Teacher interviews also support the finding that students exhibit a renewed interest in mathematics following an applied math course. Contains 36 references. (DDR)

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Student Perceptions about Applied Mathematics

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STUDENT PERCEPTIONS ABOUT APPLIED MATHEMATICS

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Introduction

Instruction in applied academic courses, including mathematics, has received increased attention as a part of Tech Prep initiatives as well as other efforts to restructure the delivery of education in our schools. The SCANS (1991) report, Tech Prep, Title III of the Perkins Vocational and Applied Technology Education Act (1990) and initiatives related to school to work all suggested the need to restructure education to better develop the skills needed to enter the increasingly complex work place. Students must not only understand basic concepts but how to apply them to real world problems (Marshall & Tucker, 1992). Recent work in cognitive psychology about how people learn has also suggested the need to explore alternate approaches to facilitate student learning (Resnick & Klopfer, 1989).

The Tech Prep initiative has encouraged curriculum reform including the teaching of applied academic courses. This is consistent with the three foundation principles that Hull & Parnell (1992) identified for Tech Prep. The related principle stated that students will learn better when courses are taught in a real-world context. Under Title III of the Perkins Act, Tech Prep must, among other things, build student competence in mathematics, science, and communications through a sequential course of study; and lead to employment placement (Brustein, 1993). A recent study by Bragg, Layton, & Hammons (1994) examined local Tech Prep implementation in the United States. Of the seventeen outcomes, the top three were: "improved knowledge and skills in math; increased problem-solving, thinking, and reasoning skills; and improved employability skills and work readiness" (p. 50).

In a national study of the evaluation of Tech Prep activities, Custer, Ruhland, & Stewart (1995) found that "a major thrust of Tech Prep has to do with developing and implementing processes for restructuring schools and instituting fundamental changes in the way that education is delivered in America. This is related to national as well as local initiatives, such as the association with the broader range of educational reform that is occurring across the nation" (p. 14).

Tanner & Chism (1996) reported on a study of applied math student performance in Georgia. They compared the results of students taking applied math 2 and algebra 1 on the SAT-M using scores on the Iowa Test of Basic Skills as a covariant. They found that the students in applied math made significantly higher scores on the SAT-M. The Center for Occupational Research and Development (CORD, 1994) also reported no significant differences in scores of applied math 2 and algebra 1 students on a researcher developed instrument designed to assess algebra skills.

The applied mathematics approach differs from traditional math courses. The traditional approach most often presents concepts with practice problems. Little attention is given to application. The applied curriculum is structured to present concepts in context to real-life events. Activities that bring abstract ideas into concrete, hands-on activities are foundational. Applied course activities are designed to reflect a psychological framework of associative learning and learning style preferences. Balsam (1985) stated, "learning occurs in a cognitive or associative context of what has been learned before and in an environmental

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context that is defined by the location, time, and specific features of the task at hand" (p. 1). Context improves the learning process by allowing relationships to be drawn among associated components.

Several early psychologists emphasized the importance of association in learning (Guthrie, 1935, Hull, 1943; Thorndike, 1931). The structure of these traditional theories consisted of an association between two elements. Current cognitive theory differs from these early educational psychologists. Biggs, Hinton & Duncan (1996) stated, "learning is a process of knowledge construction rather than knowledge absorption and storage; people use what they already know in constructing new knowledge; and learning is closely related to the context in which it takes place" (p. 35).

In addition to contextual and associative learning theories, recent work on the individual learning preferences of students is important to the overall cognitive development of individuals. Applied mathematics assumes that students learn in differing ways. This idea of differing learning preferences is often called learning styles. Researchers have concluded that people learn in different manners and rates. The idea that individuals comprehend, order, and synthesize concepts in differing manners and rates is the premise of learning styles. Lewis & Steinberger (1991) explained that learning style is the characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with and respond to the learning environment. Numerous studies have confirmed that the majority of students can accomplish a task given in an educational environment that matches or compliments their learning style preference (Drummond, 1987; Dunn & Dunn, 1978; Kolb, 1984; Messick, 1984; Pumipuntu, 1992).

An emphasis on context as it relates to facilitating student learning is supported by cognitive theory. Recent sources provided information about theory and its impact on learning (Raizen, 1989; Thomas, 1992; Jones, 1992; Thomas, Johnson, & Anderson, 1992). Resnick & Klopfer (1989) suggested that skill and content should be taught at the same time and that students should be provided experiences using real tasks to provide an opportunity for contextualized practice. The work of cognitive psychology and learning style theories provided a theoretical base for this study. This research study was conducted with a foundational assumption that learning is greater for many students when methods accommodate active involvement and differing learning preferences and that the perceptions of students about the subject will be influenced by cognitive success.

Many educators believe that students in applied courses learn more and have greater interest in the subject matter. Therefore, there is increased interest in offering more courses taught using an applied approach. The bulk of recent research has centered around instructor perceptions and concerns about applied academics (Bristow, 1994; Dennison, 1993; Greene, 1993; Kelly, 1993; Pollard, 1990). It was unclear just how effective the *Applied Mathematics* curriculum is in promoting positive perceptions about math as a subject. With positive reports from teachers, students, and administrators, a study to determine the effect of these courses on student perceptions was warranted.

Purpose of Study

The purpose of this study was to examine the perceptions of students enrolled in applied mathematics 1 and applied mathematics 2 courses based principally on the Center for Occupational Research and Development's *CORD Applied Mathematics* curriculum with any teacher supplemented material philosophically aligned with the CORD methodology. The

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specific objective was to compare the perceptions of students in applied math and algebra 1 about mathematics as a school subject.

Methods

This quasi-experimental study employed a posttest-only control group design to examine the perceptions of students in applied mathematics and algebra 1 courses. A posttest-only design was used to avoid pretest treatment interaction and the regression problem associated with gain scores (Gay, 1992). Students in algebra 1 were used as a control group to provide a means of comparison, because the applied curricula were developed to provide algebra skills. Cluster sampling was used with random selection of intact classes.

Four Missouri school districts received a state-funded grant in 1993 to fully implement an Applied Mathematics curriculum based on the 36 units from CORD (1993) as well as three other applied courses. The districts each offer applied math 1 courses, applied math 2 courses, as well as algebra 1 and other advanced math courses. Schools from these districts were selected to provide data for this study. Twenty-six of 67 randomly selected class sections of applied mathematics and algebra 1 in the four Missouri districts were used to provide data for 490 students. Complete sets of data were obtained from a total of 254 subjects. The number of data sets was reduced due to missed tests, data available on the covariant tests, and student attrition and transfers. The data sets included scores on *the Work Keys Applied Mathematics* test, the Pre-Algebra/Algebra subscore of the Mathematics portion of the P-Act+ which were reported in another study (Keif & Stewart, 1996), the Math Perception Survey, and a demographic survey. Eighth-grade MMAT Math and Reading scores were also obtained for each subject.

The group-administered Math Perception Survey was modified from the Purdue Master Attitude Scale Toward Subject Matter by Remmers (1934). The 7-point Likert scale uses brief statements in both positive and negative form that require the subject to select an answer ranging from Very Strongly Agree to Very Strongly Disagree. Mean scores could range from one to seven.

Modifications of the instrument included replacing the words "subject matter" with "math". The twenty item scale was shortened by McCaskey (1987) from the original 90 items. The shortened version of the Purdue Master Attitude Scale yielded a Cronbach's Alpha estimate of internal consistency of .95 throughout this study. McCaskey (1987), likewise, reported a .95 internal consistency during his study.

An instrument was developed for this study to gather descriptive data about the participants. These data were used to provide a basis for assessing homogeneity among groups. The group-administered student information survey was used to collect information about grade, previous math success, class assignment, and intentions after graduation.

Data were collected in late April 1995 as students completed course requirements. School counselors then supplied coded individual mathematics and reading scores on the state mandated Missouri Mastery Achievement Test (MMAT) given to all eighth grade students. The MMAT was selected to provide performance data because it was the only test providing a common data base among the four schools.

The General Linear Models (GLM) analysis of variance procedure was used throughout the study in lieu of standard analysis of variance because of the unbalanced

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design. All data analyses were performed by computer using a SAS statistical package (SAS Institute Inc., 1989). Data for the objective were analyzed using the GLM analysis of variance procedure. The related hypothesis was tested at the .05 alpha level. The least square means procedure was used for post hoc analysis.

Findings

Descriptive data and eighth-grade MMAT scores were examined to ascertain profiles of students in the three classes. Most (224) of the students were in either grades 9 or 10. The composition of the groups was 58% male for applied math and 56% female for algebra 1. When asked which best described their last math class, nearly half of the students in applied math 1 responded 8th grade general math. However, 76% of the students in algebra 1 selected pre-algebra/algebra (see Table 1).

Table 1

Percentage of Students Reporting Last Math Class in which Subjects were Enrolled

	9th/10th grade general math	Applied math 1	8th grade general math	Pre-algebra algebra
Applied math 1	8%	8%	46%	38%
Applied math 2	7%	61%	0%	32%
Algebra 1	2%	4%	16%	75%

Students also reported the grades usually received in math class. As reported in Table 2, algebra students reported higher grades in previous classes.

Table 2

Percentage of Students Reporting Grades Received in Math Class

	A's	B's	C's	D's/F's
Applied math 1	9%	35%	47%	9%
Applied math 2	7%	46%	39%	7%
Algebra 1	23%	42%	25%	10%

Eighth-grade Missouri Mastery Achievement Test (MMAT) scores in reading and mathematics were a significant component of the data sets. These scores were obtained from counselors at the schools. The mean MMAT math score for students in applied math 2 was 299 while the mean MMAT math score for students in algebra 1 was 372. Similarly, the

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mean MMAT reading score for students in applied math 2 was 294, while the mean MMAT reading score for students in algebra 1 was 331 (see Table 3).

Table 3

Group Means of Eight Grade MMAT Reading and Mathematics Scores

	Mathematics	Reading
Applied math 1	287	286
Applied math 2	299	294
Algebra 1	372	331

The objective was formulated to determine if the level of student perception about mathematics as a school subject differed among students in the three types of mathematics classes. A GLM analysis of variance procedure was performed on the perception data of the three groups. The mean score for students in applied math 1 was 4.61. The mean score for students in applied math 2 was 4.63. The mean score for the students in algebra 1 was 4.89. There was no significant difference ($F=2.05$ $p=.13$) among these scores at the .05 alpha level.

Implications

It was concluded that students completing applied mathematics 1 and students completing applied mathematics 2 possess comparable perceptions toward math as a school subject as students completing algebra and instruction based on the *CORD Applied Mathematics* curriculum is useful for students who learn using applied, activity-centered approaches.

The results of this study are important to educational decision makers as they judge the success and value of courses emphasizing an applied or contextual approach. The evidence suggests the applied courses provide for positive perceptions about mathematics as a subject. The use of real world examples and the activities provide a basis for students to develop an appreciation for the use of mathematics on the job.

The results of this study lead to several areas of discussion. Isolating curriculum and instructional strategies in educational research is very difficult because of external factors such as class selection by students and previous experience in mathematics. As such, statistical control and qualitative judgments were necessary to aid in interpreting the findings.

Many teachers were excited about the interest and progress that students displayed using the applied approach. It was difficult, however, to relate these observations directly to student perception data because of confounding variables. A concern raised early in the study involved the entry skills of students enrolling in applied math. Use of 8th grade Missouri Mastery Achievement Test (MMAT) scores in reading and math provided information about entry skills. While students in applied courses had not been as successful in learning math skills, their perceptions about mathematics as a subject was positive and similar to those of algebra students.

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Personal interviews with teachers revealed a renewed interest in math among students in applied mathematics classes. Therefore, the similar perceptions may have been influenced by the contextual nature of the applied classes and the success realized by these students.

The comparable perceptions about math that was found for the applied mathematics groups when compared to the algebra 1 group may well be attributable to the contextual approaches based on the learning theories described in the theoretical base section. The *CORD Applied Mathematics* curriculum provides for a hands-on approach that actively engages the learner. Specific activities such as popping corn and calculating the percent of popped kernels may be used as contrasted to a traditional approach of working problems from a guide sheet. Applied learning proponents frequently mentioned that some students truly comprehend only after active participation. For some, construction in the classroom through psychomotor means precedes construction in the cognitive. These students often prefer to learn through hands-on, activity centered projects like those used in applied math.

Educational leaders as well as local school districts should be better prepared to make informed decisions concerning the use of applied mathematics courses. The positive perceptions of students in these courses has been documented, providing decision makers additional information needed to help derive reasoned conclusions about the role of contextual approaches in education.

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